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AUTHOR Abbas, Abdullah; Gilmer, Penny J.

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ABSTRACT

Most science instructors in classes for prospective teachers emphasize the learning of basic facts and definitions in science from textbooks and lectures. Relatively little emphasis is placed on understanding science knowledge and how to use it in daily life. Most students in these classes tend to learn science, probably without understanding, through memorizing facts, equations, and definitions because the instructors and students belong to different discursive communities separated by a wide gap. The problem this presents is that of how to overcome the language barrier that prevents members of the student's community from crossing the border into the instructor's world of science. In the present study, the use of journals as a nonthreatening mode of discourse encouraged all students to interact actively with their instructor. The use of journals stimulated active learning through facilitating interaction between students and their instructor in a manner that is not traditionally present. The students' meaningful learning of science was enhanced by expressing ideas, asking and answering questions, and presenting the troubles they had to their instructor. Contains 17 references. (Author)

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THE USE OF JOURNALS IN SCIENCE TEACHING AND LEARNING FOR PROSPECTIVE TEACHERS: AN ACTIVE TOOL OF STUDENTS' REFLECTIONS

Abdullah Abbas
203 MCH
Florida State University
Tallahassee, FL 32306-3032
aabbas@mailer.fsu.edu

Penny J. Gilmer
Professor
Department of Chemistry
Florida State University
Tallahassee, FL 32306-3006
e-mail: gilmer@iris1.sb.fsu.edu

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Abstract

Most science instructors in classes for prospective teachers emphasize learning of basic facts and definitions in science from textbooks and lectures. Relatively little emphasis is placed on understanding science knowledge and how to use it in daily life. Most students in these classes tend to learn science, probably without understanding, through memorizing facts, equations, and definitions because the instructors and students belong to different discursive communities separated by a wide gap. The problem is how to overcome the language barrier that prevents members of the student's community from crossing the border into the instructor's world of science. The use of journals, as a non-threatening mode of discourse, encourages all students to interact actively with their instructor. The use of journals stimulated active learning through facilitating interaction between students and their instructor in a manner that is not traditionally present. The students' meaningful learning of science was enhanced by expressing ideas, asking and answering questions, and presenting the troubles they had to their instructor.

Introduction

In recent years, more than 400 national reports (Hurd, 1994) have called for reform in science teaching and learning in the United States (e.g., National Research Council, 1996; National Science Teachers Association, 1992; Rutherford & Ahlgren, 1990). Many of these reports focus on shortcomings of science education back to the elementary level, where the preparation of prospective elementary teachers to teach science is a major concern. Science classes for prospective teachers are inconsistent with the visions described in these reports. Most science instructors in these classes emphasize learning of basic facts and definitions in science from textbooks and lectures. Relatively little emphasis is placed on understanding science knowledge and how to use it in daily life.

The problem is that most prospective teachers tend to learn science, probably without understanding, through memorizing facts, equations, and definitions because the instructors and students belong to different discursive communities separated by a wide gap (Tobin & Roth,1995). It is how to overcome the language barrier that prevents members of the student's community from crossing the border into the instructor's world of science. Therefore, Tobin and Roth (1995) emphasized that in order to bridge this gap and facilitate the students' learning of science "it is necessary for the teachers to employ a form of discourse that allows students to use their discursive resources in the process of building of understandings of physics." Accordingly, some educators have begun to think about alternative ways to create more interactions between learners and instructors in such classes. Students actively involved in the learning process use prior experience and knowledge to construct meanings in new situations. They are expected to learn with understanding, to appreciate science, and to recapture their natural curiosity for science (Gilmer, Barrow & Tobin, 1993).

Why is there a need for research to understand the role of using journals to enhance science learning in college level classes? Generally, learning about science in classes for prospective teachers is performed in rote fashion. Less attention is paid to student-teacher interactions which could promote meaningful learning. Although there is some interaction between the science teacher and some target students in the class, using journals promotes interaction between all students and their teacher. The findings of this study may provide interpretations about how to enhance students' learning in these classes through implementing active tools, such as journals and portfolios, for communication with their teachers. Constructing knowledge about such tools will provide insights into how to improve teacher education and science teaching and learning at the college level in this country and elsewhere.

In the context of an undergraduate level course requirement for prospective elementary

teachers, we found that the use of student journals facilitated the discourse between students and the instructors of the course. The use of journals is one of the active tools to stimulate students' reflections and interactions. It allows a non-threatening mode of discourse to develop between students and their instructors so meaningful learning can be developed in science classes (Duffy, 1993).

Design of The Study

Interpretive research techniques were used in this study, as described by Erickson (1986) and Guba and Lincoln (1989). The main source of data for this study is student journals of a physical science course. Additional data sources, such as videotapes of classes and interviews with the instructors and students, were utilized to ensure that the study has what Guba and Lincoln (1989) referred as confirmability. In order to maximize the trustworthiness of the study, the criteria set forth by Guba and Lincoln (1989) were used during the study process. After the journals were researched, the findings were taken back to the instructors and students. The instructors read through the study and made changes that they felt were appropriate. Also, presenting transcripts of the interviews to the instructors and the students enabled them to provide feedback to the researchers, frequently suggesting changes to improve the credibility of the study.

The class this paper is based on was a physical science course, designed especially for elementary prospective teachers, taught in the spring of 1996 at a state university in the Southeast of the United States. Twenty one students (all of them females) were involved in the class. Returning back the audiotape transcriptions for the instructor and students to read and reflect provide what Guba and Lincoln (19890) refer to as member checks. The first author's prolonged and intensive engagement (Guba & Lincoln, 1989) in the class during the whole semester added to the credibility of the study.

Every student was required to keep a journal throughout the semester. Artifacts, such as worksheets that students did in the class, were included in the journals. The students were required to write their notes, thoughts, ideas, and questions about what they learned in the classroom. The journals were taken up roughly every 2-3 weeks. The instructor would read and react to students' thoughts or questions posed in the journals.

The main approach adopted for the implementation of this study emphasizes meaningful learning based on constructivism (Glasersfeld, 1989) and co-participation theory (Lemke, 1995). The constructivist approach assumes that science learning is not a teacher-centered activity, but is learner-centered. Within a constructivist framework, participants are empowered and given opportunities to act and reflect on their actions. Through interaction with others they can negotiate meanings of actions to arrive at a consensus on what has been learned. Co-participation implies, as stated by Tobin (in press), "the presence of a shared language that can be accessed by all participants to communicate with one another such that meaningful learning occurs" (p. 1). When active science learning and co-participation occur simultaneously, students are empowered to engage actively in the process learning, and have the autonomy to ask questions when they have problems (Tobin, in press). They have the power to talk and express their ideas in the class, they can argue or ask for help when they do not understand (Tobin, in press).

Constructions and Discussion

Analysis of students' journals, in addition to use of audiotape data, indicated that the

journal was an active means to promote interaction between students and the instructor. A dialogue was created between students and the instructor as the course progressed. The journals allowed students to provide input to the instructor and a forum which the instructor could use to correspond with students. Mark (all the names used in the study are pseudonyms), the instructor in the course also believed that the journals promote and facilitate student-instructor interaction. It helped him to determine whether students learn science with understanding or not. Students believed that the journals enhanced their learning, although they had different ideas about how the journal should be organized.

Mark's View of Journals

Using the journals in science classes facilitates discourse between the instructor and students. The journal allows a non-threatening mode of discourse to develop between students and their instructors. It encourages students to show their frustrations and confusions, and to show what the students did and did not understand about science. Reading students' comments allowed Mark to see how students (mis)understood science knowledge in the classroom. Mark commented on the use of the journals to encourage students to express their ideas as follows:

> The nice thing about the journal is that it is a very non-threatening way to stretch that dialogue. If [a student writes] that "when I boil water I create [oxygen and hydrogen atoms]." And [the instructor responds] "No you don't, steam is still water molecules, just it is in a gaseous stage, they are far apart." And [the student reads] that, maybe [he or she] feels kind of stupid, but [the student] doesn't feel like he or she is being embarrassed in front of the whole class. It is much easier than if on the board he or she goes ..... Journals are great for that. (February 5, 1996)

It seems that the use of the journals in the classes for prospective teachers is consistent with Mark's goal to maximize students' participation in the learning process. Mark explained the importance of the journal to create environments in which student-instructor interactions is promoted as:

> I do try to keep them interested. I try to do things that engage the students. What I do depends on the class and the nature of the students. That is what makes the journals so useful. Anything that gets the students to put their ideas into words lets you see whether they understand what they are doing. You never know if what you are doing in class is working until you get the students to talk or write. (February 15, 1996)

Mark believed that the student journal is an effective mean of assessing students' learning. The use of examinations or tests in the classrooms may enable the instructor to determine whether students learn science with understanding or not. Oral or written interactions in the classrooms can be used by instructors to determine what students do understand and what they do not. Mark emphasized the importance of coparticipation in the classroom to evaluate meaningful learning as follows:

> Exams are not very good at determining what someone knows. Exams don't have the 'give' and 'take' of a conversation. But if I talk to somebody, I can tell whether they understand the piece

> of science I want them to understand, and you can tell when they understand it, the click- 'Oh! I got it. It is like so and so.' (February 15, 1996)

Recently, there has been considerable attention given to developing approaches to assessment, such as portfolio and journals, based on students displaying evidence of what they have learned (Duschl & Gitomer, 1991; Collins, 1991). The use of portfolios and journals as an alternative means of assessing students' learning enables the instructor to determine what students have learned in the classroom. Tobin and Tippins (1993) suggest that the use of portfolios and journals enables students to show what they know, opens the opportunity for instructors to get in touch with what students know on an on-going basis, and can provide a basis for a learner-focused dialogue between students and their instructor.

Furthermore, Mark used the journals as a way to encourage students to participate and ask questions whether through their journals or in the class. For instance, in his response to Muna, Mark reacted to her comments on the dry ice and liquid nitrogen activity as follows:

> Muna, you are off to a good start here. Keep writing- both assigned entries plus anything you like. It is hearing and reading your ideas that allows us to give the best feedback for each of you. And feel free to ask questions in class too.

Students' Views of Journals

It appeared that students had different views about setting up of a journal in the classroom. At the beginning of the course students were asked to include their thoughts, comments, and questions in their journals. After a period of time they were asked to reorganize their journals by writing their notes in addition to their thoughts, comments, and questions. Some students would rather include their notes in the journals but others would not. For instance, Muna, for example, commented on using her journal in the class as follows:

> Now we are just taking our notes in it, and putting our comments and our notes next to it. It is fine. I like it a lot better than before where you were just putting your thoughts and summaries. I didn't really like that because I thought it was usaless, I didn't really see that much of a point to it. ..... Now it is fine, because if you have a question or a comment you can still put it next to it, next to your notes. (March 30,1996)

On the other hand, Nora expressed her feeling about how she liked her journal to be organized as:

> I didn't like people to tell me how to take notes. ..... I have learned to take notes a certain way, and when people tell me how to take it in a different way, in a different book, it just throws me off. ..... I like writing questions and comments in it, but I'd rather take my notes in my own way. (March 30, 1996 and April 22, 1996)

Shyma wrote why she did not like to take notes in her journal as follows:

> ..... I prefer to take notes separately, assess what was done, and then transfer notes and comments in my journal. (April 22, 1996)

Although students had different views about how journals should be organized, many of them believed that the journals enhanced their learning. Ann, for example, commented about her journal as follows:

> As much as I didn't like writing in journals, it really helped me to better understand what we were learning. In my journal, I would write why things happened the way they did in our experiments and a basic summary of what we covered in class. This really helped me to understand the concepts. (April 22, 1996)

Another student believed that the use of journals was an effective mean of enhancing learning and interaction in the classroom.

> I like the journals. They are a good incentive to be able to express our thoughts and write our notes down collectively. (April 22, 1996)

Discourse in the Journals

Students used the journals to express their thoughts and questions about learning activities in the classroom. They could explain what they did understand and what they did not. Furthermore, they used the journals to write about their confusions, frustrations, and their personal problems that might inhibit their learning.

Analysis of students' reflections in their journals on learning about temperature, for example, indicates how this tool empowered students to express their opinions and engage actively in the process of knowledge construction. For instance, Aisha wrote in her journal the following description of what she did in a group activity that involved the use of dry ice, liquid nitrogen, and a balloon:

> We experimented with small pellets of dry ice. We stuck one pellet of dry ice in the balloon and tied it up. The dry ice begins to blow the balloon up slowly, and then eventually almost appears to stop until we pick it back up and shake it and bring the inside to motion. We also did some experiments with the liquid nitrogen. [Mark] stuck a racquetball into the liquid nitrogen, and it immediately turned into a glass-like state. [He] then threw the ball against the wall, and it shattered into many pieces. We stuck our [inflated] balloons with the [sublimed] dry ice in it into our cup filled with liquid nitrogen. The balloon seemed to collapse and [shriveled] up when coming in contact with the [liquid] nitrogen.

Students used their journals to say if they saw a liquid or not in the balloons that had been filled with air after inserting them in liquid nitrogen. Salwa wrote in her journal "I saw a liquid in the balloon for a second, but then it disappeared as the balloon got its shape back. I have no idea what it is." But Lisa wrote in her journal "Although we were asked to see something inside of the air-filled balloon many times, I never really saw anything worth noting. Nothing

was inside of the balloon." Written comments such as these allowed the instructor to see how students (mis)understood science knowledge in such experiments.

Students found the journals an efficient tool to explain what they did while they were working in groups or individually to conduct activities in the classroom and to express their feeling toward such activities. In the balloon, wall, and water activity, for example, Nora wrote in her journal the following comments about the activity:

> I rubbed the balloon against my hair and I got it statically charged. Then I held the balloon next to a steady stream of water, and the water went toward the balloon. I thought the water and balloon experiment was cool! I already knew about the balloon sticking to wall after rubbing it on your head (although I didn't know why until now), but I had never heard the water and balloon experiment before today.

Muna used her journal to explain what she has learned in the balloon, wall and water activity as well as to pose some questions that she constructed in the activity.

> I blew up the balloon, rubbed on [my] hair to gain statistic electricity and put [it] next to dripping water. When I put the balloon next to it, the water was drawn towards the balloon. The balloon gains excess electrons when rubbed in hair. When I put a balloon on the wall, it sticks because there are (+) forces on the wall which can't move. Do all things have both (+) and (-) charges, except for single elements? So why doesn't the balloon stick to a pen? If you have one balloon stick to board, can you stick another balloon on the balloon on the board? Will it stay?

The journals allowed a channel through which the students could express their confusions or frustrations without being face to face with the instructor. Nora wrote the following when she had difficulty with Laws of Thermodynamics:

> I understand all the laws of thermodynamics, but I'm just a little fuzzy when we get to the fridge, engine, and entropy. What that has to do with the second law .....?

In the class in which Carnot's Theorem was taught, Nora expressed her frustration in her journal as follows:

> I don't understand Carnot's Theorem. I think the lecture went way too fast and [was] confusing. All of these formulas mean nothing to me because I don't know what they mean.

Mark responded to Nora's confusion about the laws of thermodynamics asking the student to reflect more about her understanding as follows:

> A number of students expressed this. We have talked about this material since this lecture. Does it make more sense now? Did the homework help?

Muna was confused if she could use the word 'water' to describe liquid water, as she

learned in the Earth Science class, or just using the term, water. She wrote in her journal:

> The liquid water stays as H_2O in liquid and steam because it is still H_2O. Our Earth Science teachers always had a fit when we just called it water. They said 'liquid water.' What's the difference between (aq) and liquid?

Mark responded to Muna's confusion as:

> Both water and steam are H_2O. The only difference is the phase- but that is an important difference. (Aq) just means dissolved in water.

As a final note about the types of journal entries, the students used the journals as a way to communicate with the instructor about their personal problems, such as when they were sick or why they were absent. Fatima, for example, wrote in her journal to explain why she was absent:

> I have been very sick lately. I had to go to the doctor and he told me to go to another doctor. ... I am trying my best to keep up with this class and all my other classes. I didn't want to seem like I was I just making up excuses. But I am really doing my best.

Conclusion

Discourse refers to a "social activity of making meanings with language and other symbolic systems in some particular kind of situation or setting" (Lemke, 1995, p. 8). Meaningful learning is considered to occur in classrooms through social interactions when the discursive practices, such as spoken or written language, of participants are constantly changing in response to social structures and power relations (Tobin & Roth, 1995). The symbolism of communicated language "evokes subjective meaning in the hearer or reader that is dependent upon their prior knowledge of the conventions of language" (Taylor & Campbell-Williams, 1993, p. 12).

When student-instructor interaction in a science class is rare, it means that the instructor and students belong to different discursive communities with a wide gap between them (Tobin & Roth, 1995). The language used by the instructor is inaccessible to by students. Furthermore, it may create a barrier that prevents members of the students community from crossing the border into the instructor's world of science (Griffiths, 1996). In such an environment students might not involve in social interactions, such as arguing or raising questions, because of a fear that they do not know enough to do so. Social interactions using a shared language enable the instructor and students to communicate through verbal or written discourse.

Findings of the study indicate that the use of journals in science classes for prospective teachers, as a non-threatening mode of discourse, encourages all students to interact actively with their instructor. The use of journals stimulated active learning through facilitating interaction between students and their instructor in a manner that is not traditionally present. The students' meaningful learning of science was enhanced by expressing ideas, asking and answering questions, and presenting the troubles they had to their instructor.

A student journal allows the instructor to evaluate the progress of the class as well as the progress of individual students. Data from students' journals showed how they had the autonomy to express their thoughts and attitudes about the science teaching and learning in the course. The instructor found the process of journals was an efficient way to encourage students to talk about their problems and reflect on what they understand and what they do not understand. This tool helped the instructor and students to understand each other through using a common language in their communication.

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